Outstanding Features in

This Month's Issue

Electrocoated Fabrics

The underlying principle of electrocoating fabrics has been known to mankind for more than 2,500 years. In 1940, after thirteen years of research, the electrocoating process began to be employed in the textile industry. (See page 2).)

Industries of Tomorrow

In the laboratories of today are born the new industries of tomorrow, states Richard W. Sulloway, treasurer, Sulloway Hosiery Mills. (See page 12.)

Water Resistance

Because of research, it is now possible to predict the water-repellent properties of properly treated fabrics before the cloth is actually woven. (See page 18.)

Sequoia Bark Fibers

A new product of research is a fiber obtained from the bark of redwood trees. (See page 26.)

Financing Research

Fundamental research is seldom of such a nature that the problem can be quickly solved. Accordingly, financial arrangements should be such as to insure completion of the project. (See page 28.)

High-Voltage Electricity Harnessed to Produce

Electrocoated Fabrics

THE UNDERLYING PRINCIPLE of electrocoating fabrics has been known to mankind for more than 2,500 years. In Benjamin Franklin's time the first natural law applying to electrocoating was discovered. The first application of the law in the field of coating was in 1926. Thirteen years later the electrocoating process began to be employed commercially in the textile industry.

Principle Involved

The principle on which electrocoating is based is demonstrated whenever one holds a glass rod which has been rubbed with a piece of silk over bits of paper—the bits of paper first stand on end, then jump to the rod and stick to it in an upright position. The law states that when any substances are electrified or charged, those substances which are charged with a like polarity repel each other and those which are charged with an opposite polarity attract each other.

In 1926, at the Watervliet, N. Y., plant of Behr-Manning Corp., a division of Norton Co., production of sandpaper was started experimentally according to an electrocoating process developed by Elmer C. Schacht. Over the next six years an extensive program of experimentation was carried out, and in 1932 the process was ready for large-scale exploitation. Since then Behr-Manning and its licensees have made many millions of dollars worth of coated abrasives by methods involving the electrostatic deposition of finely divided materials.

Research on the adaptation of the electrocoating process to the fabrication and decoration of textiles began in 1936. Arnold Print Works, North Adams, Mass.,

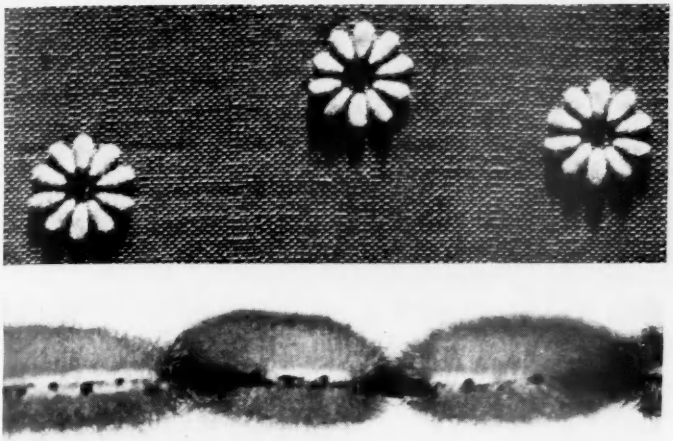


Fig. 1. Fibredown fabric; photomicrograph of cross-section shows cut fibers forming design on both face and back

solicited the cooperation of Behr-Manning on the latter problem; and the combined efforts of the research and development staffs of the two companies culminated in the introduction in January, 1940, of a new type of applique fabric, which has become well-known in the trade under the name Fibredown. At the Behr-Manning plant efforts to date have been concentrated largely on development of all-over pile fabrics, known as Norzon fabrics, for upholstery, floor coverings, and other uses.

One of the Fibredown fabrics introduced by Arnold Print Works is illustrated in Fig. 1; the photomicrograph of a cross-section shows cut fibers forming a design on both the back and face of the base fabric. A feature of Fibredown fabrics is that they can be laundered or dry-cleaned without damage to the pattern. Fibredown ginghams, voiles, and lawns in geometric, floral, stripe, and check designs are being produced for dress goods, evening frocks, blouses, housecoats, aprons, neckwear, etc.

One of the Norzon fabrics developed by Behr-Man-

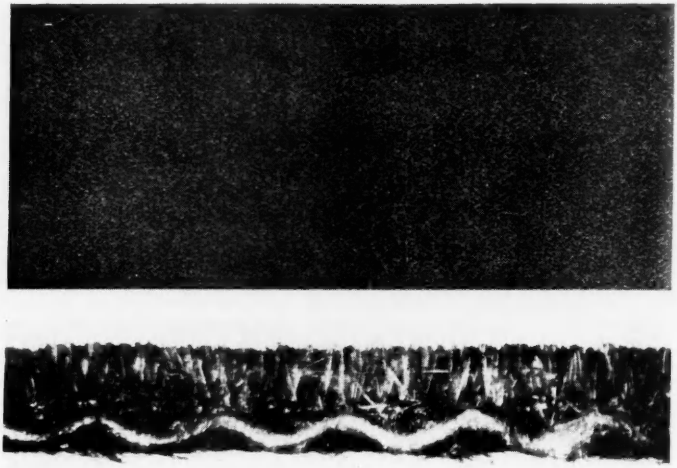


Fig. 2. Norzon fabric; photomicrograph of cross-section shows cut fibers standing erect

ning Corp., is illustrated in Fig. 2; the photomicrograph of the cross-section shows the cut fibers standing erect. Among the features of the Norzon fabrics are that they are waterproof and the pile is resistant to both wet and dry abrasion.

Method Employed

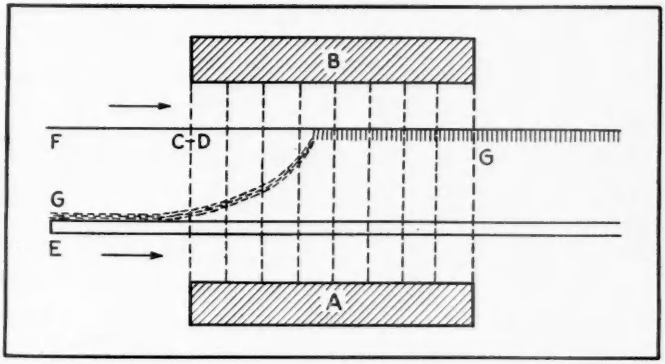
The method employed in the electrostatic process, as applied to textiles, is illustrated diagrammatically in Fig. 3. The backing fabric, *F*, coated on the face with latex or another suitable adhesive, passes between the negative electrode, *A*, and the positive electrode, *B*. The cut fibers, *G*, of cotton, rayon, wool, etc., are carried on the conveyor belt, *E*. Entering the electrostatic field between the two electrodes, the cut fibers first rise and stand on end with their long axes parallel to the lines of electrical force *C–D*, and then are propelled at high speed toward the positive electrode. Voltages range from 40,000 to 60,000. Intercepted by the fabric, the cut fibers imbed themselves endwise in the adhesive. Because of

the fact that the fibers are mutually repellent while in the electrostatic field, they become separated and uniformly spaced before they reach the backing cloth. The final step in the procedure is to subject the fabric to high temperatures in order to harden and set the adhesive so that it will bind the fibers permanently. A diagrammatic sketch of an electrocoating unit, showing the electrocoater, curing oven, and take-down, is shown in Fig. 4.

As many as 300,000 individual pile fibers, each 0.02 to 0.06 inch long, can be applied to 1 square inch of backing fabric. Incidentally, the apparatus can be so arranged that the cut fibers are propelled downward onto the backing fabric, rather than upward, as described.

The method employed at Arnold Print Works for production of Fibredown fabrics differs in several details from that used in manufacture of Norzon fabrics. Before the base fabric is passed through the electrostatic field, the adhesive, which is a combination of synthetic resins, is applied by means of a continuous stencil process to those areas which are to carry the design. As a result, only those cut fibers which imbed themselves in the adhesive are permanently attached to the cloth. Again, the electrostatic apparatus is designed to permit appli-

Fig. 3. Schematic diagram showing arrangement of electrodes, conveyor, backing fabric, and cut fibers



cation of the cut fibers to both the face and the back in one run.

The amount of research involved in the adaptation of the electrostatic process to production of textiles is indicated by the fact that in 1940 fifteen members of the Behr-Manning research staff were working on problems pertaining to electrocoating of textiles. One of the early problems which had to be overcome was the prevention of matting or treeing of the cut fibers between the electrodes. Whereas a substantially constant potential on the electrodes was effective in the coating of sandpaper, it was found necessary to employ a pulsating or alternating potential in producing electrocoated fabrics. Again, it was discovered that it is necessary to maintain a uniform moisture content in the fibers by means of controlled humidity. Further, to obviate shearing of the electrocoated fabrics a method for cutting the fibers to a uniform length had to be developed. Many experiments were necessary before dyeing and drying procedures were evolved which would not impair the fiber characteristics required for electrocoating.

Other Problems Encountered

The problem of finding suitable adhesives called for a great deal of study and experimentation. For example, the viscosity of the adhesive must be such that the required penetration of the fibers is obtained. Controlled methods, had to be worked out for curing or ageing such adhesives as rubber, synthetic rubber, and synthetic resins. As Fibredown fabrics used for dress goods have to withstand repeated laundering or dry-cleaning and subsequent ironing, an adhesive had to be found which will withstand these operations. A number of otherwise desirable adhesives had to be eliminated because they are thermoplastic and cannot be subjected to normal ironing operations. Finally, certain suitable synthetic resins were found.

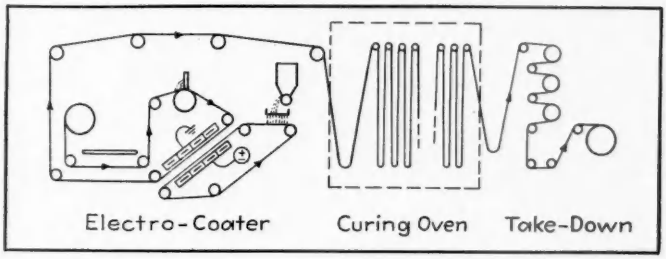
With the major technical problems solved, Behr-Manning was ready late last year to start large-scale pro-

duction of Norzon fabrics. Then came the war in the Pacific, and the necessity for conserving for military purposes the rubber and other materials which had been found most satisfactory for manufacture of the all-over pile electrocoated fabrics. The company's plans had to be changed; introduction of Norzon fabrics to the trade had to be postponed. But research did not stop.

Today Behr-Manning is carrying on further work on the improvement, modification, and extension of the electrocoating process as applied to textiles. There is an elaborate research program on the behavior of fibers in electrostatic fields, at various frequencies, and in different gases. Electrostatic deposition of fiber mixtures and of fibers which have been subjected to various chemical treatments is being investigated. The search for new and better adhesives continues.

Laboratory, field, and consumer tests of those types of electrocoated fabrics which have been produced thus far indicate that they possess superior resistance to abrasion and other desirable characteristics. Again, their production cost is relatively low as compared with the cost of producing pile fabrics by conventional methods. It appears certain, therefore, that the electrocoating process will in the future find extensive application in the manufacture and decoration of textiles. Further, development of this process may lead eventually to the widespread utilization of electrostatic and other electrical forces in fabrication of textiles.

Fig. 4. Diagrammatic sketch of electrostatic coating unit



RESEARCH ACTIVITIES

"Textile mills cannot afford now to forsake research merely because they have plenty of business for the moment," stated Dr. Carl Z. Draves, president of American Association of Textile Chemists & Colorists, at the annual meeting of that association. "We must realize," he continued, "that momentum in research requires years to develop because it depends primarily upon men who become competent in research only after years of training and experience." Speaking on the research point of view, Dr. Draves said that it is possessed by the person who seeks by all the means at his disposal, and much common sense, to arrive at the solution of an assigned problem; the research minded person must preserve an open mind and be possessed by a spirit of adventure.

The preference rating order granting a priorities rating of A–2 to equipment needed by research laboratories has been interpreted officially to apply only to material which will itself be used in conduct of scientific research or which will enter into the production of material which will be so used. The preference rating cannot be applied to obtain material to be used for construction or expansion of laboratory buildings.

"Research, which has played such an important part in the growth of this country, looms large in any contribution we are making to the war effort," states Dr. Camille Dreyfus, president, Celanese Corp. of America. "Through research this company in the past year or more directed its products into channels once reserved exclusively for imported fibers, such as Japanese silk. Fortisan, the super-strong yarn

developed by Celanese, is being used in the making of parachute and balloon cloth and for several other purposes. Its entire production, which is increasing steadily, has been pledged to the Government."

Frank S. McCall, chief chemist at Ford Laboratories, has been made technical director of the Herty Foundation Laboratories, Jacksonville, Fla. Mr. McCall had previously been employed by Herty Laboratories in charge of the research on manufacture of rayon from southern pine.

Initial meeting of the Industrial Fiber Society was held Dec. 4–5, 1941, at Georgia School of Technology, Atlanta, Ga. The purpose of the society is to bring together men in textile mills and laboratories to study fibers and their applications. W. R. Marsden, director of Bibb Mfg. Co., acted as chairman of the organization meeting. He was assisted in the formation of the group by B. Reid Clanton, research chemist, Callaway Mills; and Otto Morningstar, of the research division, West Point Mfg. Co. During the meeting a symposium was held on the "Evaluation and Correlation of Fiber and Yarn Properties," at which papers were presented by Prof. K. L. Hertel, of University of Tennessee, Dr. Carl M. Conrad and Dr. Enoch Karrer, of the Southern Regional Research laboratory, Dr. Milton Harris, director of research for the Textile Foundation and Textile Research Institute, and Malcolm E. Campbell, of U. S. Department of Agriculture.

Fuller E. Callaway, Jr., president of Callaway Mills, La Grange, Ga., and vice-president, Textile Research Institute, Inc., recently announced a donation of $190,000 to the board of education of the city of La

RESEARCH ACTIVITIES

Grange, the money to be used immediately for the building of new school facilities in the southwest La Grange community, and for the improvement of existing equipment.

To insure a continuing supply of engineers, chemists, and physicists needed in the industrial and research sides of the expanding war program, establishment of a U. S. Professional Training Reserve is advocated by Dr. Harold S. Booth, professor of chemistry, at Western Reserve University. Under this plan college and university students doing satisfactory work in these fields would be enrolled in the Professional Training Reserve by their draft boards and would remain there as long as their college grades merited it.

Effect of stretch in slashing spun viscose warps on weaving quality and fabric dyeing properties is discussed in confidential progress report No. 6 issued to those cooperating in the research on warp sizing being conducted by Textile Research Institute, Inc.

A new process for the prevention of shrinkage in wool, said to be so simple that wool at any stage can be treated completely within a few minutes, has been developed by Martin R. Freney and M. Lipson, scientists employed at the McMaster Laboratory in Sydney, Australia. The process is still in the experimental stage, but it is stated that all who have seen the new method tested agree that it renders wool goods practically unshrinkable. Wool to be rendered shrinkproof is immersed for 1 min. in a solution of potassium hydroxide in denatured al-

cohol, then squeezed and passed to a bath of sulphuric acid dissolved in denatured alcohol or water. It remains in this bath for one minute; the function of the second bath is to neutralize any excess potassium hydroxide left in the wool. Washing and drying complete the treatment.

The Economic Research Committee of the Textile Research Institute, Inc., met at the Hotel Roosevelt, New York, Friday, February 6. This was the first meeting of the committee under the chairmanship of Stanley B. Hunt. The other members of the committee includes Miss Irene L. Blunt, Wm. W. Carman, Jr., Stephen J. Kennedy, Frank D. Levering, James G. Torrens, and Douglas G. Woolf.

Appreciation of labor's stake in research was voiced recently by John P. Burke, president-secretary, International Brotherhood of Pulp, Sulphite, Paper Mill Workers. Said Mr. Burke, "The contributions of enlightened management, engineers, technicians, and chemists in developing this great industry must not be overlooked or minimized as a factor responsible for the higher standard of living that the pulp and paper workers now enjoy. The pulp and paper industry is able to pay higher wages today because of improved methods of production which enable the mills to produce more paper at less cost than ever before."

Tests to establish scientific standards of the warmth-retaining and warmth-withholding values of clothing under actual conditions of human wear are being conducted at the University of Minnesota, under a special grant from Munsingwear, Inc.

In the Laboratories of Today Are Born the New

Industries of Tomorrow

By RICHARD W. SULLOWAY

Treasurer, Sulloway Hosiery Mills

INDUSTRIAL RESEARCH has long been regarded as an important agency in reducing production costs, as well as in increasing business through development of new or improved products, or through new uses for old products. As a matter of fact, such application has come to be so commonplace, particularly in the larger organizations, that today research is recognized as an essential auxiliary to progressive management.

As far back as 1850 there were in this country research laboratories or experimental shops, as they were then called. One of these stood in my home town of Franklin, N. H., and was owned and operated by one Herrick Aiken and his two sons, Jonas and Walter.

Variety of Inventions

Out of that shop came an amazing variety of inventions—more than 100 in all. Among them were a shower bath; a vacuum cleaner; a machine for making wood screws, the patent rights on which they sold for $125,000 —quite a sum for those days; and most important of all, the first circular knitting machine with independently moving latch needles. In that shop Walter Aiken designed and built the first steam locomotive for the cog railway line up Mount Washington. The story of those men and their inventions should some day be recorded, for it contains much of fascinating interest and is full of

Richard W. Sulloway, treasurer, Sulloway Hosiery Mills

inspiration for research workers and inventors of the present day.

As pointed out by President Compton, of Massachusetts Institute of Technology, and by William L. Batt, of SKF Industries, who is actively associated with the National Defense Advisory Commission, research may well be carried on as a safeguard against the inevitable transition from a wartime to a peacetime program. New and better things will be wanted by consumers then, as in the past. What will they be? Research may be depended upon to provide the answer.

The writer has greatly enjoyed his modest part in developing the steadily growing appreciation in New England of the meaning, use, and value of research as an ally of modern progressive management. So far as my research experience in the Sulloway Hosiery Mills is concerned, comparatively little can be said at the present time. Interest in research has never been absent, but what was done in the past came largely through individual initiative. There was no definite research program.

Notable Accomplishments

Notable among the accomplishments within our organization was the development of apparatus for pres-

sure dyeing of yarns and raw stock. This process involved the dyeing of both cotton and worsted yarns on spring tubes, the theory being that by compressing six or seven packages together in column form, the resistance to the dyes could be equalized in each package and would result in even dyeings. The idea worked out successfully and a new industry sprang into life. This was the Franklin Process Co. of Providence, R. I., which today enjoys a large and prosperous business. One of the packages of yarn in the first batch dyed under this process (over which I had personal supervision) is now in the Smithsonian Institution, in Washington, D. C.

One of our developments permitted us to make, on circular seamless hosiery machines, wool inserts to be worn within leather mittens—this for the United States War Department. More recently a glove has been developed on the same machines. If we had been told a dozen years ago that such articles could be made on seamless hosiery machines, we would have taken it as a joke.

We have come to realize the importance of a real research program at Sulloway Hosiery Mills. We have now employed a competent engineer and have given him a relatively free hand to study the processes, products, and technical problems of the company with a view to eventual suggestions for improvement or development.

It is increasingly true in New England and all over the nation that in the laboratories of today are born the new industries of tomorrow. The New England Council has unquestionably put in motion much constructive thought among manufacturers in New England. It has pointed out to small manufacturers in particular that no company is too small to conduct research; that research is by no means to be considered the embroidery on the fabric, but is definitely an essential part of it.

(Abstract of an article, "Value of Research to Smaller Concerns," in a recent issue of the *Executives Service Bulletin*, published by Metropolitan Life Insurance Co.)

Storage Tests Carried Out by U. S. Department of Agriculture Show

Cotton Changes Color

THAT RAW COTTON changes in color during storage is revealed in a recent report by Dorothy Nickerson, color technologist, Agricultural Marketing Service, U. S. Department of Agriculture. Tests carried out over a five-year period with six varieties of cotton indicate that during storage cotton increases in chroma (degree of yellowness) and that spots in white or light spotted cottons tend to decrease in number and size. The study was undertaken because of periodic reports regarding changes in color of baled cotton held in storage.

Duplicate samples of six well-known commercial varieties of cotton were distributed to fifteen locations for office and warehouse storage. After two years' and five years' storage, each sample was measured for color, and all spots were counted and compared with marked photographs of the original samples. Except for one variety, change in tinge was not so great for the first two years of storage, but was quite significant for all varieties after five years. Samples stored at Galveston, Tex., Houston, Tex., and Mobile, Ala., showed more change than those stored at New Bedford, Mass., New York, Washington, D. C., El Paso, Tex., and San Pedro, Cal. On the whole, second picking changed less than first picking.

All cottons lost a high percentage of their spots in two years and gained a few during the next three years. Change in number of spots seems to depend more on the variety of cotton than on the location of storage.

Textile Research Institute Announces New Plan for

Cooperative Research

THE EXECUTIVE COMMITTEE of the Textile Research Institute, Inc., after several conferences with the Scientific Advisory Committee of the Textile Foundation, has developed a plan for a new type of cooperative researches in the industry. These will supplement the type of cooperative researches, already under way, whereby a specific subject has been chosen, and subscriptions to the research solicited from many mills interested in it.

Under the new plan, a relatively small group of mills in any of the various divisions of the industry may get together under the auspices of the Textile Research Institute and agree to subscribe a certain amount of money each year for at least a predetermined length of time for the prosecution of research on problems affecting the specific branch of the industry concerned. A committee appointed on behalf of the subscribing companies will confer with Dr. Milton Harris, director of textile research for both the Institute and the Foundation, and after consultation with the Executive Committee of the former, a program for the coverage of that particular research will be outlined. During the period through which this program is continued, the contributors' committee will continue to serve in an advisory capacity.

Any manufacturers interested in learning more about possibilities under this plan are invited to write to Edward T. Pickard, executive secretary, Textile Research Institute, Inc., 10 E. 40th St., New York.

Research Can't Wait

AN EDITORIAL

► In 1941 American industry spent over $117,000,000 for research. The expenditure this year will be fully as large, if not larger. Much of the research in 1942 will be directly related to the war effort. But much of it will be devoted to the development of new products to meet post-war needs and conditions.

► Extensive researches now being carried out by the plastics industry, the paper industry, the rubber industry, the abrasives industry, the glass industry, the dairy industry, and the lumber industry are of significance to the textile manufacturer. In all these, and in other industries, persistent endeavors are being made to develop and perfect new products. Some of these products are directly competitive with textiles; others are potential raw materials for the manufacture of textiles.

► Today the textile mills are busy. Textile manufacturers are confronted with the titanic task of developing all the goods required for military purposes and essential civilian needs. They are confronted with numerous immediate production problems.

► *But research can't wait.* There is a greater need now than ever before for a vigorous textile research program. There is no time to waste if the textile industry is to do its full part in development of new and improved types of textiles required by our armed forces. There must be no delay if the textile industry, through research, is to be prepared to meet the new conditions and new competition of the post-war era.

Study Reveals Relation Between Fabric Construction and

Water Resistance

TREATMENT OF FABRICS to resist the penetration of water without destroying the air porosity necessary for bodily comfort has grown to tremendous proportions during the last decade and particularly in the last three years. Today, water-resistant fabrics are used for active sports clothes; for ski jackets; for golfing, hunting, fishing and sailing outfits; raincoats; reversible topcoats; jackets; and children's snow suits. Use of water-resistant finishes has been specified by the Q.M.C. for added protection in army field jackets, ski troop parkas, parachute troop uniforms, overcoat linings, and a host of other military needs. It is estimated that more than 20,000,000 yards of cotton fabrics are treated with water-resistant finishes each month for civilian and governmental purposes.

Yet fabrics are still selected for resistant finishing with little or no knowledge of the relation between construction and water resistance. Serious and costly confusion has thus existed in the trade as a result of attempting to produce water-resistant finishes on cotton constructions which had neither been designed nor intended for such use.

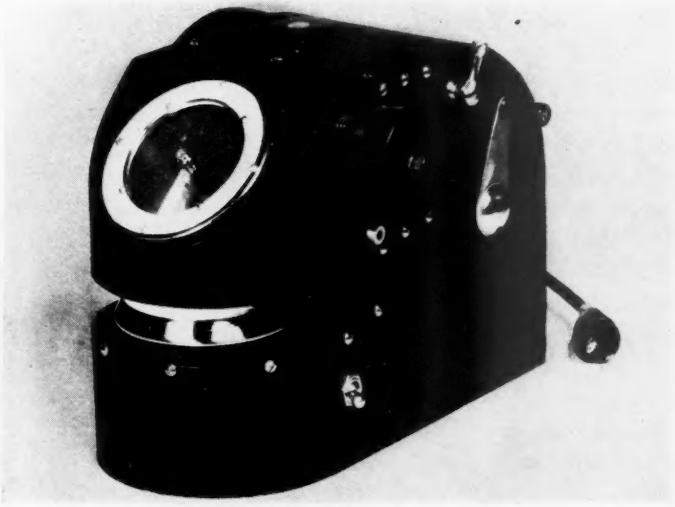
To provide first-hand data on the relation between cotton-fabric construction and water resistance 52 different fabrics were assembled at one finishing plant, where they were kier boiled, bleached, and vat dyed. Part of each fabric was then treated with one type of water-re-

pellent finish and another part with a second type of water-repellent finish. The finished fabrics were then sent to a central laboratory where they were studied, analyzed, and tested to check the efficiency of the finishes and the construction of the cloths.

Results of this research were reported at the annual meeting of the American Association of Textile Chemists & Colorists, held in Pinehurst, N. C. The report, which was presented by the New York Section (not the Rhode Island Section as stated in the December issue of TEXTILE RESEARCH), was awarded first prize in the intersectional contest. As a result of the investigation, it is now possible to construct fabrics on which the water-repellent properties of properly treated fabrics can be predicted before the cloth is actually woven.

Samples of the 52 fabrics were analyzed in the gray and after finishing to determine width, count, weight, and size and ply of warp and filling yarns. Samples of treated fabrics were subjected to the following tests:

Gurley Permeometer for testing porosity of fabrics



Fabric construction and water resistance

No.	Fabric	Gray Count	Weight Yds./lb.	Yarn Number		Test Results						
				Warp	Fill.	A	B	C	D	E	F	G
1	Poplin	100 × 58	2.40	37/2	16/1	10	100	NP	NP	51	22	24*
4	Poplin	102 × 64	2.72	46/2	22/1	11	100	NP	VSP	39	30	30*
7	Poplin	114 × 58	2.89	31/1	17/1	5	100	CP	CP	22	83	96*
11	Plain Cloth	158 × 140	5.75	87/1	83/1	11	100	CP	SP	45	60	54*
12	Plain Cloth	142 × 154	5.48	71/1	71/1	7	100	CP	SP	45	55	55*
15	Broadcloth	142 × 74	3.99	82/2	98/2	10	100	CP	CP	39	57	62*
19	Broadcloth	136 × 60	3.68	36/1	40/1	14	100	CP	CP	22	123	132*
23	Print Cloth	80 × 80	4.25	28/1	44/1	10	100	CP	CP	16	335	241*
25	Print Cloth	64 × 60	5.39	28/1	40/1	12	100	CP	CP	10	841	733*
26	Gabardine	124 × 72	1.72	28/2	25/1	13	80	CP	CP	26	53	58*
28	Gabardine	110 × 78	1.85	16/1	20/1	13	100	VSP	NP	32	62	52*
30	Herringbone	92 × 52	1.52	16/1	7/1	9	90	NP	NP	28	38	41*
31	Herringbone	66 × 48	1.58	9/1	9/1	12	100	CP	SP	27	47	55*
33	Twill	104 × 56	1.72	33/2	25/2	12	100	NP	NP	35	34	37*
34	Twill	104 × 56	1.56	15/1	12/1	10	100	VSP	NP	36	35	39*
40	Twill	88 × 44	2.07	14/1	9/1	12	100	CP	CP	19	154	112*
43	Warp Sateen	120 × 60	2.38	22/1	18/1	15	90	CP	SP	32	68	78*
44	Warp Sateen	116 × 60	2.43	21/1	17/1	11	100	CP	SP	24	95	102*
46	Flannel	49 × 41	3.51	26/1	11/1	12	100	CP	CP	24	142	129*
47	Flannel	50 × 40	3.46	25/1	11/1	11	100	CP	CP	25	161	123*
48	Sheeting	64 × 68	3.10	19/1	24/1	13	80	CP	CP	18	161	175*
51	Sheeting	34 × 28	2.97	8/1	7/1	13	80	CP	CP	7	714	599*

A. Immersion test for repellency: percent moisture absorbed. **B.** Spray test for repellency: A.A.T.C.C. Spray rating. **C.** Impact test for penetration: NP = No Penetration; VSP = Very Slight Penetration; SP = Slight Penetration; CP = Complete Penetration. **D.** Abrasion test for penetration: Symbols as above. **E.** Air porosity: Permeometer reading—0 = No Porosity; 1600 = 100% Porosity.
* Untreated Fabric.

(A) A.A.T.C.C. immersion test; (B) A.A.T.C.C. spray test; (C) impact penetration test; (D) rubbing penetration test; (E) A.A.T.C.C. hydrostatic pressure test; and (F) permeability test.

The impact penetration test is essentially the spray test in all details, except that the spray drop is 24 in. and a piece of blotting paper or absorbent cloth is inserted beneath the cloth being tested in order to show the amount of water driven through the test cloth after the standard 250 c.c. of water at 80° F. has sprayed on it from a height of 24 in. The gradings "No Penetration," "Very Slight Penetration," or "Complete Penetration" were used to describe the results qualitatively.

The rubbing-penetration test was developed to measure the water forced through a repellent fabric by mechanical action. It was carried out by clamping a dry, weighed sample of absorbent cotton cloth over the lower end of a short cylindrical block of wood attached to a standard A.A.T.C.C. Crockmeter. The cloth to be tested was then clamped over the absorbent material and rubbed 30 complete strokes, under a constant pressure, on the bottom of a pan containing a shallow layer of water. The absorbent liner was then quickly removed and weighed immediately. The per cent moisture absorbed by the liner was calculated and represented the amount of water which penetrated through the fabric being tested.

The air porosity tests were made on a new type of Gurley Permeometer constructed to measure more accurately the air flow through the interstices of cloths.

Actual test results on some of the fabrics treated with one type of water-repellent finish are shown in the chart on page 20. The influence of construction on two popular textiles which have been treated with repellent agents in an identical manner is illustrated by the two poplin fabrics, Nos. 4 and 7. These two cloths may be considered of equal weight; each running approximately 2.75 yards per pound. No. 4 fabric has a 46/2 ply warp and

D. Abrasion test for penetration: Symbols as above. E. Air porosity: Permeometer reading—0 = No Porosity; 1600 = 100% Porosity.
* Untreated Fabric.

22 singles filling; No. 7 cloth has a 31 singles warp and 17 singles filling. The number of threads per inch in each cloth is about the same, and the distribution is not dissimilar; that is, the ratio of warp to filling is 1.6 in No. 4 and 2.0 in No. 7.

Note the important point that the variable factor is the size of the yarn. This difference in yarn size is responsible for leakage in No. 7 fabric during the penetration tests, and it is also responsible for the difference in porosity.

The hydrostatic pressure value of poplin No. 4 is 39 centimeters; this is 9 centimeters above the standard suggested as necessary to protect against leakage. On the other hand, poplin No. 7 has a resistance of only 22 centimeters; this is below the normal average for satisfactory repellent clothing.

It was found that the hydrostatic pressure and the porosity tests may be correlated so that if one value is known, the other can be obtained. This may be illustrated by a graph prepared by plotting breathability against the standard A.A.T.C.C. hydrostatic pressure test values. At approximately 35, the hydrostatic pressure and air porosity values are equal. It was found also that hydrostatic pressure values may be correlated with impact penetration values, thus showing that air porosity may be used to predetermine the properties of the finished textile even before it is treated for repellency.

This means that the protection which may be expected from a fabric after proper water-resistant finishing may be accurately foretold in less than 30 seconds by means of an air porosity test on the untreated fabric. Further, the investigation has shown that by preliminary selection of proper yarns, type of weave, and without change of facial characteristics, a fabric may be constructed on which the repellency effects may be foretold before the fabric is actually woven. (The report in full was printed in the Jan. 5, 1942, issue of *American Dyestuff Reporter*.)

RESEARCH AIDS

Electron Microscope

Opening up to view infinitely small particles, the very existence of which could only be surmised with other instruments, the electron microscope provides a valuable research tool for science and industry. This new instrument, which permits study of objects even more minute than the wavelength of light, is capable of use with the same facility as an optical microscope. Undoubtedly it will reveal many heretofore unknown facts about fibers, dyes, and chemicals. It should lead also to a better understanding of the effect of various chemical and mechanical treatments on the fundamental properties of textiles.

From now on, textile manufacturers will begin to hear more and more about the electron microscope and the discoveries made with it in their own and other fields. Although use of the electron microscope will be confined at first to large research laboratories, everyone having any interest in textile research will want to familiarize himself with the principles of this important research aid.

The electron can be thought of as a particle which at an electron velocity of between 30,000 and 100,000 volts has a wavelength only 1/100,000 that of the wavelength of light. Because of this short wavelength, the resolving power of the electron microscope is much better and a much greater magnification can be obtained. The electron microscope now available gives a magnification of 100,000 as compared with 2,000 for a light microscope.

Fourteen years ago, it was demonstrated mathematically for the first time that a very close analogy exists between the action of a magnetic or electric field of rotational symmetry on an electron beam and the action of a glass lens on a light beam. Because of this analogy, the electron microscope can be constructed with the same types of essential elements as is a light microscope, the only difference being that every light element is replaced

by a corresponding electronic element. The corresponding elements of the two types of microscopes are shown in the following table:

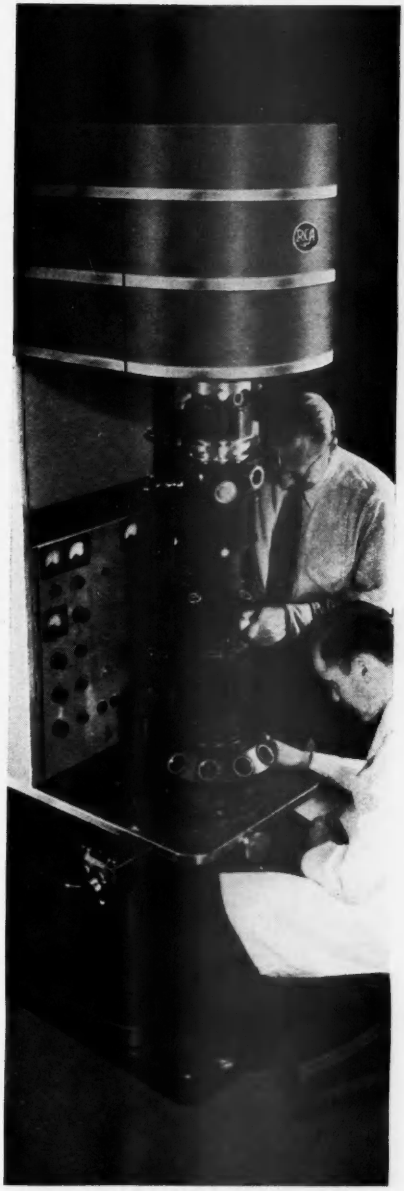
Light Microscope	Electron Microscope
Light Source	Electron Source
Condenser Lens	Magnetic Condenser
Objective Lens	Magnetic Objective
Projector Lens (Eyepiece)	Intermediate Projector
Observation Screen or	Fluorescent Screen or
Photographic Plate	Photographic Plate

The accompanying illustration shows an electron microscope with its associated power supply and control panel. The electron source is operated at voltages between 30,000 and 60,000, and, to provide ample protection of the operator from the high voltage and X-rays, is inclosed in the lead-incased upper hood. The electron beam coming from this source is concentrated on the specimen by the field produced in the condenser lens coil. The specimen, which is supported on a very thin nitrocellulose membrane suspended across the opening of a fine mesh screen, is clamped in the tip of a cartridge very close to the second field lens produced in the objective coil. A plate which supports the specimen cartridge constitutes the movable stage. The specimen motion is transmitted to this plate from the exterior of the evacuated system by means of fine screws and metal flexible bellows.

The electrons, after passing through the specimen, are focused by the object lens coil into an intermediate image, and the projection lens coil produces a further magnified image on a large fluorescent screen in the final viewing chamber. Six observation windows, which are placed to allow binocuar vision for careful observation, enable a number of spectators to view the image simultaneously. After a selected field of view is focused, and the magnification adjusted to the desired value, a photographic record may be made by merely removing the fluo-

rescent screen and allowing the electron image to strike a photographic plate, which is carried in a holder in the vacuum, immediately below the screen. Magnifications from 1,500 to 25,000 are obtainable and the definition obtained in the photographs is sufficiently fine to require further optical enlargement to obtain full useful magnification. Among present users are American Cyanamid Co., Celanese Corp., Du Pont, Interchemical Corp., Dow Chemical Co., General Electric Co., National Bureau of Standards and Massachusetts Institute of Technology.

The electron microscope was developed by RCA. Mfg. Co., Inc., Camden, N. J.



For Alleviating Wool Shortage
Lumber Company Introduces

Sequoia Bark Fibers

A DECADE AGO the bark of sequoia or redwood trees was a waste product from the production of redwood lumber. However, the research department of the Pacific Lumber Co., was conducting experiments on recovering fibers from the bark and utilizing them for thermal-insulating purposes. After a development of several years, a suitable process for recovering the fibers was developed, application methods were evolved, and an insulating material called Palco Wool was introduced. This material found widespread use in the cold-storage and meat-packing industries, and more recently has begun to be employed for insulating walls and ceilings of houses.

Search for New Markets

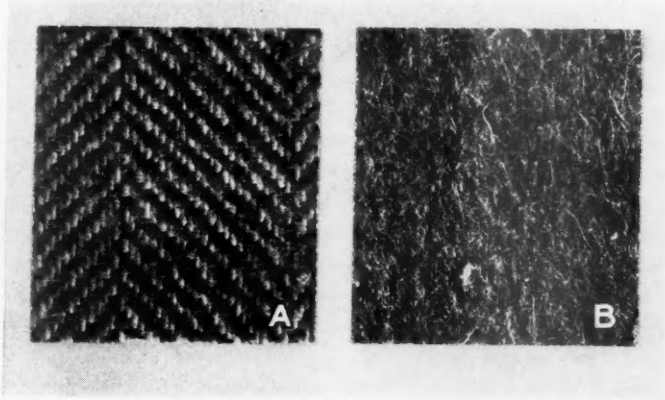
It was found that the short fibers from the sequoia bark collected in the form of felted mats and balls on the screen-belts which segregate the long fibers used for Palco Wool insulation. This discovery led to the development of processing equipment for recovering and segregating the short fibers, and also to a search for new markets for the material. The research staff of the Pacific Lumber Co., headed by C. L. Thompson, conducted a series of tests in conjunction with a woolen mill to determine whether the fibers could be employed in manufacture of textiles.

These tests indicated that the sequoia bark fibers could be blended with wool, and the resulting blend could

be carded, combed, and spun into yarns, suitable for manufacture of woven or knitted fabrics. It was found also that the blended fibers could be made into felts for making felt hats. Due to the present shortage of wool the development work was speeded up, and a variety of experimental fabrics containing from 15 to 60 per cent of redwood bark fibers were produced. These include blankets, overcoatings, and suitings. Two of these fabrics are shown in the accompanying illustration. One is a blanket material containing 33⅓% redwood bark fiber and 66⅔% wool; the other a low-priced suiting containing 40% of redwood bark fiber in the filling. Both fabrics resemble all-wool materials in appearance and handle, but are said to be somewhat lighter.

Plans are being completed to make the sequoia bark fibers available to textile manufacturers throughout the country. They will be produced at the Pacific Lumber Co. plant in Scotia, Cal., and compressed into bales for shipment to textile mills for blending with wool. It is interesting to note that the research which started over a decade ago culminated at a time when there is a need for substitute fibers to alleviate the shortage of wool.

Fabrics made from blend of sequoia bark fiber and wool; A, low-priced suiting; B, blanket material



Assurance of Sufficient Funds to Complete Project Desirable in

Financing Research

RESEARCH IS A LONG-RANGE ACTIVITY, and few research investigations can be completed in one year. Therefore, reasonable assurance that funds will be made available until a piece of research is completed is very desirable. These points are emphasized by Charles J. Brand in a discussion of technical research by trade associations in a report on industrial research prepared for the National Resources Planning Board by the National Academy of Sciences. Following is an abstract of other parts of Mr. Brand's discussion of financing which are particularly applicable to an organization of the type of Textile Research Institute, Inc.

Insure Continuity of Project

A major problem in technical research is that of financing. Unless immediate practical results permit prompt returns to the industry, interest in research projects wanes and financing becomes increasingly difficult. A deficient budget may cause delay or even abandonment of a project when ultimate success seems nearly assured and a small additional expense promises the solution. Fundamental research is seldom of such a nature that the problem can be quickly solved. Accordingly, financial arrangements should insure reasonable continuity of research projects for periods sufficiently long to permit complete exploration of the possibilities involved.

The scientist can then plan the thorough and complete program that is so often necessary for the success-

ful solution of a problem. If he must work under the handicap of feeling pressed for time, knowing that in so many months his work must terminate whether successful or not, he will be likely to take short cuts and may miss the necessary step that will insure a satisfactory product or process.

If time is all-important, sufficient financial provision should be made immediately to sustain as large a staff of scientists and technical aides as can effectively work on the project. If a mass of collective experience is necessary to "prove" the process, a well-organized corps of workers is often successful in saving much time. In many types of investigation, however, continued individual endeavor is the only practical method of approach. Such types of research may require many years to complete, and if undertaken, the time requirement must be thoroughly understood and appreciated.

Research Committee

One important factor in the coordination of trade association technical research is the research committee of the association. This committee should be charged with the direction of the research laboratory if there be one, the stimulation of pertinent research by State and Federal research agencies, and the dissemination of information regarding research. The director of research, through the executive officer of the association, acts as the agent of the committee in these activities.

The membership of a research committee should include representation from the outstanding technical, production, and sales executives of the association membership. The research committee must have frequent meetings with the director of research and members of his staff so as to stimulate and direct the work along lines of most value to the industry.

(The complete report on industrial research can be obtained from the Superintendent of Documents, Washington, D. C. Title of report is "Research A National Resource; II Industrial Research"; price is $1 a copy.)

RESEARCH BRIEFS

► PROOFING AND COATING of fabrics are discussed from a scientific viewpoint by C. L. Wall in an article "Production of Difficultly Permeable Fabrics—III," in the December, 1941, issue of the *Textile Manufacturer*. The molecular structure of the bonding medium or covering film is considered in relation to the passage of water and other diffusing substances.

► REASONS FOR ERRORS in tests to determine the effects of different methods of yarn preparation and loom settings on end breakage in weaving are discussed by V. R. Main and L. H. C. Tippett of the British Cotton Industry Research Association, in an article "Statistical Methods in Textile Research—Part 4, The Design of Weaving Experiments" in the December, 1941, issue of *The Journal of the Textile Institute*. After pointing out which errors are controllable and which are not, the authors recommend a randomized block design system of setting up weaving tests to eliminate loom and associated variations. Article merits careful study both by research men and weaving mill executives.

► VARIATION IN STRETCH or elongation of yarns is advanced as the principal cause for end breakage during weaving in a paper by Walter T. Schreiber, Bureau of Agricultural Chemistry & Engineering, U. S. Department of Agriculture, "Why Warp Ends Break in Weaving," in the January, 1941, issue of *Textile World*. Contrary to the usual beliefs, the author reasons that to prevent warp ends from breaking by increasing the yarn strength is a next to impossible task; rather, he contends that if the elongation properties of the yarns making up the

warp are uniform, within practical limits, breaks will be at a minimum. Paper, which was originally presented at a meeting of the Alabama Textile Operating Executives Association, merits careful attention by mill executives, technicians, and research workers.

► WATER-REPELLENCY of fabrics can be determined by a simple spray test described by George A. Slorviniske, of E. I. du Pont de Nemours & Co., in an article "Zelan A in the Finishing Plant," in the December, 1941, issue of *Cotton*. Author outlines methods employed in application of Zelan A to render fabrics water-repellent and use of spray test to control quality of the treated fabrics.

► CHANGING THE CELLULOSE MOLECULE by introduction of an amino group for each anhydroglucose unit of the cellulose has been accomplished by a new method described by Philip C. Sherer and J. M. Feild, of Virginia Polytechnic Institute, in an article "Preparation of a Cellulose Amine" in the October, 1941, issue of *Rayon Textile Monthly*. The process, which may prove to be of considerable technical importance, involves the treatment of cellulose nitrate with sodium amide to produce cellulose monoamine containing 8.1 per cent of nitrogen. Article describes also the preparation of an acetyl derivative of the cellulose amine.

► PROPER SELECTION of materials of construction to prevent corrosion of equipment employed in various wet processing operations is discussed by Winn W. Chase, in an article "Corrosion-Resisting Materials," in the January, 1942, issue of *Textile World*. Article reports results of a survey to determine what particular metals, alloys, and other materials are preferred by textile mill chemists and engineers for

some 50 different types of machines and stresses need for further investigation of and research on this subject.

► REASONS for eye fatigue are outlined in a brief report, "Fatigue of Workers Due to Improper Lighting," in the Jan. 2, 1942, issue of *Canadian Textile Journal*. This report of an address by George Ainsworth, at meeting in Toronto, of the Illuminating Engineering Society, comments on elimination of glare, methods of painting ceilings and walls to reflect light properly, and new type of lighting equipment designed to prevent fatigue of mill workers caused by excessive eyestrain.

► RELATION between wool quality and fiber diameter is discussed by Dr. J. L. Stoves, in an article, "An Examination of the Relation Between Wool Quality and Fiber Diameter," in the December, 1941, issue of the *Journal of the Textile Institute*. Included is a table correlating 15 qualities of wool ranging from 100s to 36s with fiber diameters in microns.

► PROGRESS in wool research is reviewed by W. O. Dolby in an article, "Recent Research on Wool and Its Application," in the December, 1941, issue of *Textile Recorder*. Article outlines recently developed processes for producing non-shrinkable wool and work on improving properties of wool by modification of the disulphide bonds.

► THE TREASURER'S REPORT in the January, 1942, issue of TEXTILE RESEARCH contained two typographical errors. In the left-hand column, correct date for balance reported under General Fund and under Warp Sizing Research is Oct. 1, 1940.